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Montana Insect Pests, 1943 and 1944

Thirtieth Report of the State Entomologist

By

H. B. Mills, J. A. Callenbach, J. F. Reinhardt

MONTANA STATE COLLEGE
AGRICULTURAL EXPERIMENT STATION
BOZEMAN, MONTANA

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Bozeman, Montana
December 1, 1944

To His Excellency
Governor Sam C. Ford
Helena, Montana
My Dear Sir:

I am submitting herewith the Thirtieth Report of the State Entomologist of Montana.

The work of this office has progressed on a fairly satisfactory basis during the past biennium. The demands on the office for assistance have grown and the personnel has shifted due to the present world-wide conditions. During this period Mr. O. B. Hitchcock, Assistant State Entomologist, entered the armed forces, and from the spring of 1942 to March, 1944, it was necessary for the State Entomologist to do considerable field work in addition to his regular duties. In March, 1944, we were fortunate in obtaining the services of Dr. J. A. Callenbach who has done an excellent piece of work in handling most of the field details during the past control season. Mr. J. F. Reinhardt, who has been the State Apiarist since 1941, has resigned effective December 31 to accept a position in apicultural research in Georgia, and this leaves the position to be filled if these services are to be made available to the beekeepers of the State. Such changes are to be expected in these trying times with the present demand for trained personnel, and will make the administration of the work of this department difficult for some time to come.

There has been a definite change in emphasis in grasshopper control during the past two years, in the shift of maximum utilization of bait from the early growing season to the fall in the winter wheat areas. In this connection this office has been cooperating with the United States Bureau of Entomology and Plant Quarantine in working out methods for large-scale marginal baiting programs which, in the fall, have proved successful in the protection of fall-planted crops and reductions in the number of eggs laid. It is felt that there will be a considerable increase in this type of control in the future if it continues to prove as successful as the programs in Yellowstone and Sanders counties appear to have been in the past two years.

Respectfully submitted

HARLOW B. MILLS
State Entomologist

MONTANA INSECT PESTS, 1943 AND 1944

Thirtieth Report of the State Entomologist

H. B. MILLS, J. A. CALLENBACH, J. F. REINHARDT[1]

INTRODUCTION

The control of insects harmful to human interests in Montana has been recognized as essential almost from the inception of the development of agriculture in the State. At the turn of the century this interest in insect control was implemented by establishment of the position of entomologist in the Montana Agricultural Experiment Station, and since that time his duties and responsibilities have been increasing. This increase is the natural result of increased emphasis on agriculture through the years, and to the introduction of some injurious species or the transfer of interest on the part of some native insects from their natural food to cultivated crops.

The control of some insects has been developed and organized within the past decade in an excellent manner through cooperation between this office and other agencies, primarily the Division of Grasshopper Control of the Bureau of Entomology and Plant Quarantine. Through this cooperation the State has received much assistance in important control problems, and some control methods have had their inception and trial in this area.

All of this has increased the work done in insect research and control and the emphasis on lines of attack. The service of the Department to the people of the State has increased but is far from reaching a satisfactory state, even after 44 years, largely due to the needs for trained personnel.

Much is yet to be found out concerning the habits of injurious and beneficial insects in the State, and basic, well-grounded control measures often await the uncovering of new facts concerning the insect pests involved. This is somewhat complicated, also, by the inaccuracies which are involved in trying to apply facts discovered concerning one species to other species, or even to the same species at different times or in different areas.

Good control measures are available for some insects, and they work satisfactorily much of the time. For others the control mea-

[1]State Entomologist, Assistant State Entomologist, and State Apriarist, respectively.

sures are poor or nonexistent. Only continuing and expanding research can solve the difficult problems.

The crying entomological need, not only in Montana, but throughout the Great Plains Area, is for adequate methods of predicting outbreaks of insects. Montana comes under the influence of a continental type of climate characterized by what are sometimes tremendous fluctuations in at least the more obvious climatic factors. This is paralleled by and possibly causes great fluctuations in populations of harmful insects. If, for example, we take the most commonly injurious insects to the wheat plant, such insects as grasshoppers, pale western cutworms, army cutworms, wheat stem sawflies, Say's stink bugs, etc., we find that they are characteristically cyclic in their appearance, and the areas infested may vary from year to year or over a period of years. Further, as is pointed out in the discussion of the potato psyllid later in this report, some insects may be sufficiently abundant in one area from year to year to warrant control recommendations every year. The same insect in another area may be present in injurious numbers only rarely, at times which are now unpredictable, making these continuing control recommendations undesirable. It should be the responsibility of the entomologist not only to give information as to **when to** control insects, but equally as much to inform those affected **when not to** apply control measures. A start in this direction has been made with grasshoppers and pale western cutworms, but prediction methods are not available for the great majority of the harmful species. This line of investigation would seem to be one of the very productive lines for future research. To function best, it should not be limited in scope to any artificial boundary such as a state or district line. If the whole region is affected by attacks of insects with these cyclic characteristics, the best and most comprehensive work can be done only when the whole region is the laboratory for study and an adequate personnel is developed to study this one problem, the problem of cyclic occurrence of insects.

In the following pages are given details on the cooperative control work, with the Bureau of Entomology and Plant Quarantine, in the control of grasshoppers, the status of other economic insects in the State, notes on new pests, and the report of the bee inspection work for the past biennium for Montana.

MAJOR INSECT CONTROL PROBLEMS

GRASSHOPPER CONTROL, 1943-44

The influence of the heavy migration of the lesser migratory locust (*Melanoplus mexicanus*) which occurred in July, 1938, had run its course by 1943. Scattered areas of threatening and severe populations existed in the State, but there was apparently little

correlation between these areas of infestation and the migratory phases of *M. mexicanus*. This is indicated by the fact that in the Triangle area where the migration was halted by the mountains, the predominant species in many fields was *Melanoplus bivittatus* rather than *M. mexicanus*. As reported in the Twenty-ninth Report of the State Entomologist[2] there was a marked decrease in grasshopper populations from 1939 to 1942. This condition carried over into 1943 with general grasshopper populations the lowest in many years. Even with these conditions, however, enough 'hoppers remained in many parts of the State to present a serious threat to the greatly increased food-production goals.

The area influenced by the great migration of 1938 was limited on its western border by the Rocky Mountains and the above remarks apply only to counties lying east of the Continental Divide. In the intermountain counties lying west of the Divide a trend almost exactly opposite to that recorded above began to develop. Scattered noneconomic infestations began to increase in numbers and by 1942 Sanders, Lake and Missoula counties reported threatening 'hopper populations. Other counties probably experienced similar increases but, with the exception of Flathead County, none of the other counties maintained County Agents, and grasshopper adult or egg surveys were not conducted in these counties.

1943 Season

Grasshopper egg surveys in the fall of 1942 indicated that in 1943, outbreaks were likely to occur in the Yellowstone River drainage, the western portion of the Triangle area, and in Lake and Sanders counties. Greatest egg concentrations were found in the Upper Yellowstone River Valley and its tributary, the Big Horn River. (Figure 1.)

Eggs were first reported hatching in the area around Billings on April 23. Subsequent cold weather during which temperatures of 24°F. on May 9 and 32°F. on June 3 were recorded retarded further hatching. Because of the delayed hatch the cold weather had little effect as a control factor. Hatching increased after June 6, but the continued cold prolonged the hatching period until the latter part of July. First adults were reported July 1. As a consequence of the irregular development all stages in development were to be found in the same area at the same time. In some instances new adults were laying eggs before all eggs of the previous season had hatched.

Egg predation was of considerable importance in reducing 'hopper populations. In some areas blister beetles destroyed as

[2]Mont. Agr. Exp. Sta. Bull. 408, pp. 4-10.

high as 75 percent of the eggs and in other areas ground beetles took an equal toll. It was estimated that an average of 25 percent of the eggs were destroyed by these predators.

Yellowstone and Big Horn counties experienced the most severe infestations. On the whole, however, infestations failed to develop as expected, probably, in part because of the climatic conditions and predation of eggs previously mentioned. Another important controlling factor that may be easily overlooked was early tillage preparations for summer fallowing. Because of the delayed hatch practically all stubble had been worked and the threat of infestation from this favored *M. mexicanus* habitat was greatly reduced.

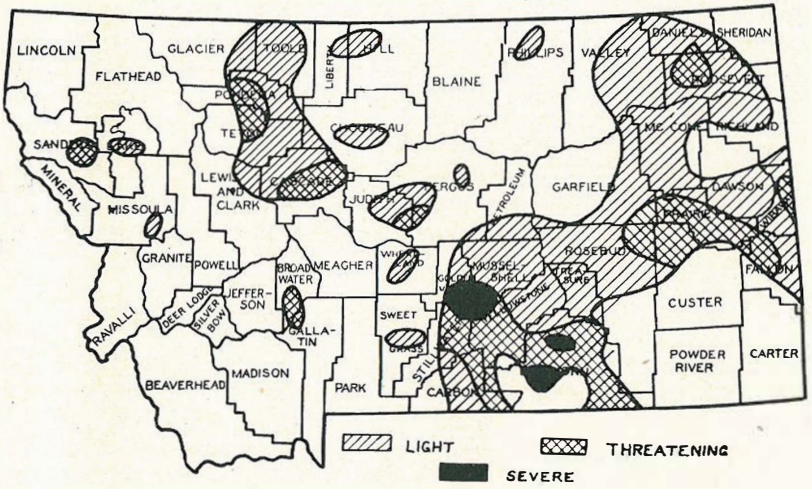

Figure 1. Grasshopper egg beds, 1943.

The baiting control program was only partially successful. The irregular development of 'hoppers and unfavorable weather made baiting difficult. Heavy weed and crop growth partially minimized the damage and partially concealed actual crop damage. Finally labor shortage caused farmers to concentrate their efforts upon harvest and other farming operations rather than upon control of grasshoppers.

Slightly over 1½ million dollars was the estimated crop loss in 1943, while savings of approximately one million dollars result from control operations. Two thousand one hundred forty-nine farmers and victory gardeners spread 1,041 tons of bait upon 208,220 acres of land.

Melanoplus mexicanus was the dominant species with *M. bi-*

TABLE 1.—CROP LOSSES FROM GRASSHOPPERS AND SAVINGS FROM CONTROL WORK IN DOLLARS

County	1943		1944	
	Losses	Savings	Losses	Savings
Big Horn	367,000	244,800	292,000	141,500
Blaine	14,500	24,300	8,800	4,200
Carbon	12,500	7,200	11,050	4,280
Cascade	19,600	15,750	10,000	150,000
Chouteau	44,000	37,000	21,500	104,000
Custer-Powder River	8,500	6,000	79,000	4,300
Daniels	20,000	—	20,000	—
Dawson	6,500	17,000	58,000	41,000
Fallon-Carter	80,000	21,000	72,299	3,720
Fergus	13,550	7,100	6,500	2,600
Flathead	—	—	8,025	23,500
Gallatin	500	1,000	2,500	5,000
Glacier	110,000	6,800	800	5,000
Granite	—	—	200	2,000
Hill	29,650	27,975	27,500	160,000
Lake	—	—	90,510	75,500
Lincoln	—	—	5,232	5,450
McCone	37,000	5,000	—	—
Mineral	—	—	4,630	5,950
Missoula	—	—	13,750	4,550
Musselshell-Golden Valley	20,000	156,500	53,000	75,000
Pondera	48,500	110,000	3,900	26,240
Powell	1,200	190	200	800
Prairie	59,000	5,550	49,000	10,250
Ravalli	—	—	4,050	3,775
Richland	8,580	905	11,300	5,850
Roosevelt	123,600	4,500	80,600	4,500
Rosebud	35,800	10,100	74,000	14,500
Sanders	143,000	10,500	65,000	58,500
Stillwater	3,400	38,000	12,500	2,060
Sweet Grass	800	350	—	—
Teton	50,000	32,500	35,000	36,050
Toole	—	—	2,000	3,000
Valley	9,450	7,390	10,900	1,900
Wibaux	—	—	85,100	—
Yellowstone	188,494	273,765	40,000	72,511
Totals	**1,635,124**	**1,071,075**	**1,238,846**	**1,057,486**

vittatus ranking next in importance. *M. packardi*, *M. differentialis* and *M. femur-rubrum* occurred in important numbers in various localities.

A significant part of the grasshopper situation in 1943 was the late season damage to fall-planted wheat. This type of damage has increased as the acreage of fall-planted grain, in areas where strip cropping is practiced, has increased. Considerable concern is being shown by farmers toward this type of damage and in some counties the principal control program has been directed toward protecting winter grain.

Federally Financed Control In 1943

The fall of 1943 witnessed a co-operative attempt by county, State and Federal representatives to reduce an incipient grasshopper outbreak by a concerted program of fall bait applications to reduce egg laying. Yellowstone County was selected for the effort. It was estimated September first that 50-75 percent of the grasshoppers in the County were located in the weedy environment found in field margins, roadsides, railroad rights-of-way and along irrigation and drainage canals. This concentration in the margins was due to the extended drouth during the summer, which matured crops early and left weedy margins the main source of green forage, and the natural tendency of *M. bivittatus* to lay its eggs in these habitats. If these concentrated populations could be destroyed before many eggs were laid, the infestation the following season would be greatly reduced. Upon this basis an extensive marginal baiting program was organized. The Bureau of Entomology and Plant Quarantine and Yellowstone County pooled mixing and spreading equipment, including a new type blower spreader, an airplane, and various traction and power-operated spreaders. County, State and Federal agencies provided supervisory personnel and labor. The Northern Pacific, Great Northern, and Chicago, Burlington and Quincy railroads supplied equipment and personnel for baiting their rights-of-way and cooperated whole-heartedly in conducting the program. The Wyoming State Entomologist, Mr. Tom Snipes, also cooperated and participated in the work. Prompt and efficient organization and conduct of the campaign resulted in the baiting of 3,265 miles of roadside margins, 271 miles of railroad rights-of-way and 412 miles of irrigation and drainage canal margins.

Success of the campaign was demonstrated by the kills obtained, the reduction in eggs laid, and the reduced population in the baited area in the spring of 1944.

1944 Season

The 1943 egg survey indicated light to threatening populations in parts of the Yellowstone River drainage, the Triangle area and Lake and Sanders counties. Reports received indicated that threatening infestations also existed in the other western counties. (Figure 2). In the spring of 1944 surveys and contacts with county officials indicated growing alarm in these counties and special efforts were made to organize these counties for effective control campaigns.

The 1944 season began with drouth conditions existing over the entire State, and severe drouth in Toole, Glacier, and counties west of the Divide. This condition still existed when the first 'hoppers hatched during the week of May 7. With drouth continuing

the hatch progressed rapidly and damage to grain in the vicinity of St. Xavier was observed May 16. By May 20, however, with the exception of the western counties and the northern parts of Toole and Glacier counties, the drouth was broken. In central and eastern Montana rain and cool weather continued throughout June with many counties reporting the wettest June on record. Conditions continued dry in Toole, Glacier, and western counties. The heavy rainfall caused considerable nymphal mortality in some counties while in others it apparently had little affect.

First adults were reported from Chouteau County the week of June 18. The cool, wet weather of June produced a situation very similar to 1943 with many late hatches reported and grasshoppers in all stages of development being found in the same area.

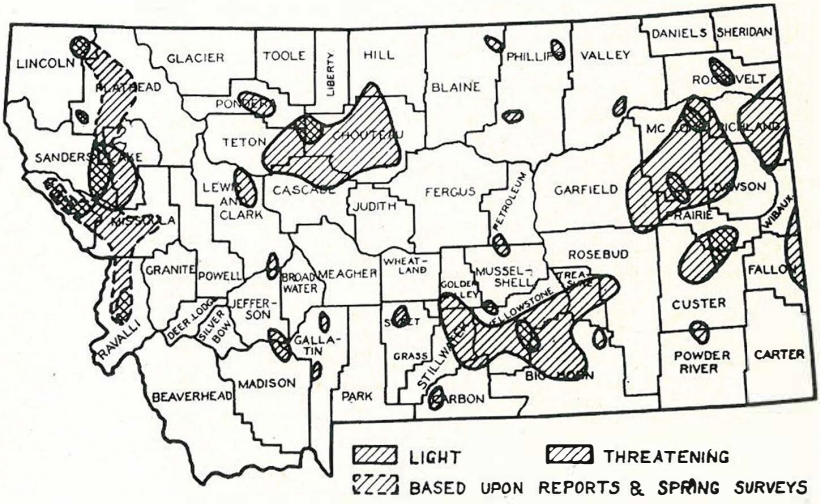

Figure 2. Grasshopper egg beds, 1944.

The most severe infestations developed in Big Horn County, the Triangle area, and the western counties. Predicted severe infestations failed to materialize in McCone County, while in Hill County infestations greater than expected developed. Unseasonable rains and predation could account for the McCone County situation and drouth conditions in the fall of 1943 may have influenced egg depositions to such an extent in Hill County that major egg beds were missed during the survey.

The dominant species over the State was *M. mexicanus*. In the Triangle area *M. bivittatus* was a dominant species and ranked second over the State. In eastern Montana *M. differentialis*, a spe-

TABLE 2.—SUMMARY OF BAIT USAGE

County	1943			1944		
	Tons bait dry wt.	No. using bait	Acres baited	Tons bait dry wt.	No. using bait	Acres baited
Big Horn	123	105	24,600	177.9	109	35,580
Blaine	5.1	15	1,020	2.1	9	420
Carbon	7.5	24	1,500	5	6	1,000
Cascade	27	65	5,400	101.9	60	20,380
Chouteau	128.3	85	25,660	149.3	115	29,860
Custer-Powder River	42.9	394	8,580	51.2	211	10,240
Dawson	39.3	65	7,860	74.8	178	14,960
Fallon-Carter	1.3	27	260	2.3	2	460
Fergus	20	40	4,000	4.6	10	920
Flathead	—	—	—	15.4	78	3,080
Gallatin	.5	1	100	3.9	2	780
Glacier	1.0	6	200	.7	1	140
Granite	—	—	—	.9	17	180
Hill	14.0	119	2,800	189.	93	37,800
Lake	—	—	—	31	161	6,200
Lincoln	—	—	—	13.1	100	2,620
McCone	8.2	3	1,640	—	—	—
Mineral	—	—	—	19.5	100	3,900
Missoula	—	—	—	10.3	300	2,060
Musselshell-Golden Valley	20.7	142	4,140	19.3	190	3,960
Pondera	25.5	27	5,100	67.5	37	13,500
Powell	.3	2	60	.3	2	60
Prairie	2.3	34	460	11.2	67	2,240
Ravalli	—	—	—	5.	221	1,000
Richland	4.6	16	920	19.8	72	3,960
Roosevelt	9	12	1,800	8.	3	1,600
Rosebud	20.	19	4,000	4.	24	800
Sheridan	14.1	52	2,820	141.4	97	28,280
Stillwater	11.5	72	2,300	4.6	5	920
Sweet Grass	1.0	4	200	—	—	—
Teton	21.7	44	4,340	28.	68	5,600
Toole	—	—	—	1.6	3	320
Valley	1.9	10	380	1.6	3	320
Yellowstone	485.5	881	97,100	51.8	22	11,360
Totals	**1,036.2**	**2,264**	**207,240**	**1,217.0**	**2,366**	**244,500**

cies which first appeared in Montana (Dawson County) in 1932, has steadily increased in importance and in 1944 was a dominant species in parts of eleven counties. Its greatest population increases have been in the valley of the Yellowstone River where its range extends as far west as Forsyth. In western Montana *M. mexicanus* was dominant with *Camnula* and *M. femur-rubrum* and *M. bivittatus* of secondary importance.

The 1944 control program during the spring and early summer was decidedly unsuccessful. Very discouraging results were ob-

tained with baits. Where grain and grass were baited some reasonably good kills were obtained but the results were erratic. Where alfalfa was baited or heavy weed growth was common, baits frequently failed completely. Many farmers were discouraged by the results and stopped baiting, and in some areas baiting was almost discontinued as a control program.

Efforts to explain these failures have not met with much success. With the change from sodium arsenite to sodium fluosilicate came an increasing number of reported bait failures and there has been a strong tendency to place the blame on the sodium fluosilicate bait. This is apparently not correct since as often as not when comparisons of the two baits were made the fluosilicate gave equal or better control than the arsenite. A more plausible explanation seems to be the different feeding habits of the grasshoppers during periods of low populations and abundant crops as compared with periods of high popuations and limited crop development. Furthermore, the war demand for maximum production has made farmers more conscious of crop losses from insects and other pests, and crop damage considered negligible in pre-war days is now of some concern. Only continued research and study will ultimately give the right answer.

During the late summer and fall, baiting gave uniformly excellent results under practically all cropping conditions. In the Camas Prairie section of Sanders County, where spring baiting, of as many as six or eight applications in a single field gave no appreciable decrease, a single baiting in late August and early September resulted in reducing a threatening population to one of noneconomic importance. The same bait was used throughout the season. Again it seems that some element, as yet unknown, in the habits and development of the 'hoppers must be responsible for this change.

Fall baiting for the protection of winter wheat has become an important part of the grasshopper control program in the strip farm sections of Montana. This is demonstrated by the bait usage in Cascade County where approximately 190 tons of bait were used and County Agent Fosse reported "practically all of the baiting this year was done from September 9 up to October 30, 1944, to protect fall seedings of winter wheat . . . " Likewise in Chouteau County 80 percent and in Hill County 37 percent of the bait used during the 1944 season was distributed after September 1.

It seems entirely possible that fall baiting will become a major part of the baiting program in Montana if continued better kills are obtained in the late season, and fall baiting programs, such as those conducted in Yellowstone County in 1943 and Sanders County in 1944, prove effective in reducing egg laying.

Losses due to grasshoppers approximated $1,238,846 in 1944.

Savings due to control operations were $1,057,486, with farmers and gardeners spreading 1,217 tons of bait on 244,500 acres.

Federally Financed Control in 1944

It was planned that a repeat baiting job would be done in Yellowstone County in the spring of 1944 to further reduce the threatening population there. It was also planned to extend the area to include parts of Big Horn, Stillwater, and Carbon counties. However, the fall baiting of 1943 and other factors combined to so reduce the population that further baiting was unnecessary in Yellowstone County. Infestations in the other counties were spotty, and heavy rains, which filled ditches, precluded the possibility of effective baiting. Consequently an area-wide campaign was abandoned in this area.

TABLE 3.—SUMMARY OF GRASSHOPPER CONTROL PROGRAM

	1943	1944
Number of counties actively engaged	27	32
Number of mixing stations	28	33
Persons using bait (includes Victory Gardeners)	2,264	2,366
Dry bait used (tons)	1,036.1	1,217
Acres baited	207,240	244,500
Estimated losses	1,635,124	1,238,846
Estimated savings	1,071,075	1,057,486

An extensive roadside campaign was also organized for a section of the Triangle area comprising the eastern parts of Pondera and Teton counties and the western part of Chouteau County. Egg surveys in this area showed a large percentage of the eggs deposited in field margins and roadsides and it seemed an ideal spot to carry on such a program. Again weather interfered to delay the program and when it finally got under way weed growth was extensive. Negligible kills were obtained from bait usage and the campaign was discontinued. This was one of the most discouraging failures of bait to control 'hoppers.

As the season progressed bait efficiency increased and it was decided to attempt a fall baiting program in the Camas Prairie, Hot Springs, Lonepine, and Plains communities of Sanders County. The population in Sanders County was predominately *M. mexicanus* and differed somewhat in that respect from the Yellowstone County population where *M. bivittatus* was an important species. Adult surveys showed threatening to severe populations with concentrations in areas where green foliage was present, primarily alfalfa.

In the Camas Prairie community practically the entire area was baited. Excellent cooperation was obtained from farmers,

county officials, and the Indian Service and Forest Service. In other communities, roadsides and some idle land were baited by paid Bureau crews but farmer participation was not so extensive.

The results of this program will not be completely understood until the spring of 1945 but an extensive egg survey seems to indicate that the threatening population in Camas Prairie has been reduced to noneconomic status. Where farmer participation was not extensive the program was only partially successful and threatening populations still exist in the Hot Springs and Lonepine communities. Because of the small area involved and the different cropping system used in the Plains community little can be concluded as to results of the campaign in this community.

While much more needs to be done in all parts of the State and with different grasshopper population complexes, there seems to be some support for fall baiting campaigns to reduce incipient grasshopper outbreaks. Where marginal concentrations exist, baiting of all field margins, roadsides, railroad rights-of-way, etc. may be sufficient. Where concentrations are in fields and areas not accessible to machinery travelling public thoroughfares, extensive baiting of fields, idle land, range, etc. must be carried on.

GRASSHOPPER OUTLOOK FOR 1945

The grasshopper outlook for 1945, based upon 1944 adult and egg surveys, is that the area of infestation will approximate that of 1944 but will increase in intensity. (Figure 3). Eastern Montana along the North Dakota line and extending in a strip

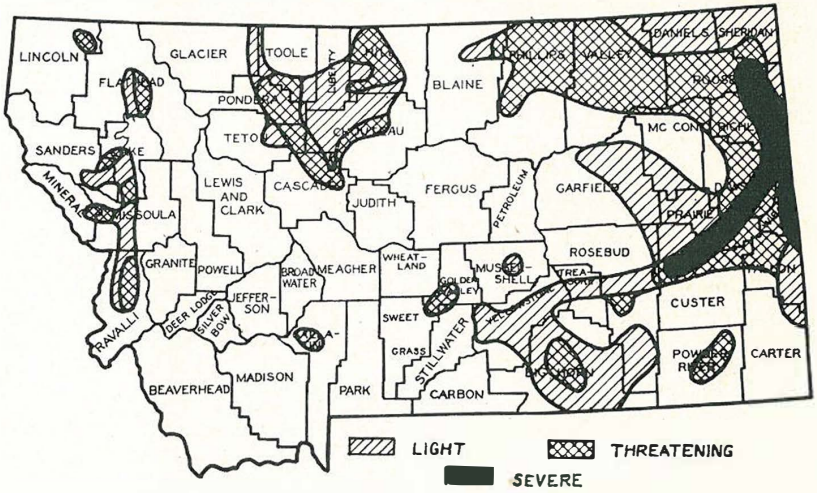

Figure 3. Grasshopper egg beds, 1945.

up the Yellowstone River to Miles City is threatened with severe populations. This comprises the area where *M. differentialis* is increasing in abundance. Extending out from this is an area of threatening populations which includes most of the drainage of the lower Yellowstone River. Northeastern counties as far west as Phillips County will be in an area of threatening populations. The Triangle area, including Hill, Chouteau, northern Cascade, eastern Teton, and Pondera and southern Toole and Liberty counties, comprises another area where populations are increasing. Threatening areas also exist in parts of Powder River, Rosebud, Big Horn, Yellowstone, Golden Valley, and counties west of the Continental Divide. It seems probable that all counties with organized campaigns will be confronted with more extensive compaigns in 1945. If drouth conditions should prevail in the wheat-growing sections, extensive damage can be expected unless well organized control campaigns are promptly and extensively carried out.

MORMON CRICKET CONTROL, 1943-44

Mormon crickets are not, at the present time, an economic problem in Montana. The last control program was conducted in 1942.

In 1943 a moderate infestation was present in Big Horn County east of Pryor on the bench between Hay Creek and Deep Creek, involving an area of about 2500 acres. Another light infestation was present southeast of Lodge Grass at the head of Owl and Little Owl creeks. Another moderate infestation was present in Beaverhead County along the Idaho-Montana line, extending from the head of Poison Creek to the head of Shineberger Creek, and comprising an area of about 3600 acres. In neither of these areas was the infestation sufficient in numbers to warrant control. Crickets were also reported as present, but in very small numbers, in northeastern Montana, the Highwood Mountains, and other scattered localities throughout the State.

In 1944, the infestation in the Pryor Mountain area had increased in numbers and in the size of the area infested. No concentrations were reported,however, which would warrant control operations. No investigation of the Beaverhead was made in 1944 but no reports indicating an increase in this area were received.

More frequent reports and observations of the presence of crickets in small numbers were made in many parts of the State in 1944. Upon the basis of these reports it would appear that cricket populations were on the increase but do not as yet present an economic problem.

WHEAT STEM SAWFLY (*Cephus Cinctus* **Norton**)

This little wasp, which has been developing slowly in numbers for the past decade, appeared in large numbers and over a considerable area during the 1943 season, and increased its area of infestation in 1944. To recapitulate briefly its history, it was first discovered in wild grasses and transferred its interest to small grains when these were planted in large acreages in the northern part of the Great Plains Area. Apparently the first injury to wheat was noted by James Fletcher in 1896 from specimens sent in to him from Souris, Manitoba. First definite injury to this crop in the United States was noted in 1909 in northern North Dakota. This injury became intense about 1916 and continued for some years after which the infestation receded. Montana is now suffering its first recorded major outbreak of this insect in small

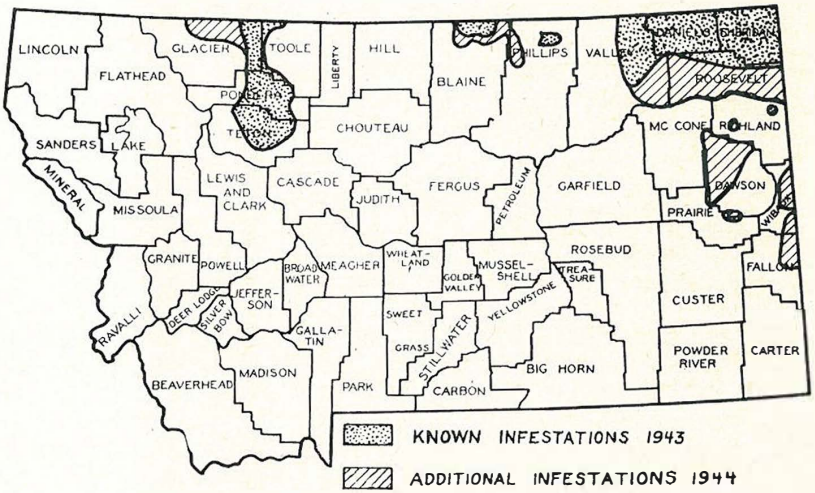

Figure 4. Distribution of wheat stem sawfly.

grains. In 1943 the infestation was most injurious in two separate areas in the State. To the west it was abundant in grains in eastern Glacier, western Toole, central Pondera, and northern Teton counties. To the east it occurred in parts of Blaine, Valley, Phillips, Daniels, Sheridan, Roosevelt, and Richland counties. During the 1944 season the western infestation did not show any striking increase in area—in some areas there was an apparent but slight reduction in intensity. The eastern area, however, developed a

heavier population, and injury was noted in the additional counties of Dawson, Wibaux and Fallon. (Figure 4).

The biology and control of this insect has been detailed elsewhere[3] and will not be repeated here. This was without doubt the insect most injurious to wheat in the State in 1944, overshadowing the injury sustained from grasshopper attacks. Spring wheat was most highly infested, some infestations approaching 100 percent. Observations made during July of 1944 in heavily infested areas indicated that barley was consistently infested, in the common varieties grown in the State, to the extent of about 10 percent, even in areas where adjacent spring wheat carried from six to seven times this infestation. The percent survival in barley, however, has not been ascertained. It would seem that, even though barley may not be an immune crop, it suffers much less injury than wheat as far as common varieties in Montana are concerned.

Several specimens of flax infested with the wheat stem sawfly have been examined. Where these insects are abundant, this attack seems not uncommon. It has been previously noted in infested Canadian areas and has been discussed by Farstad[4] who has made some detailed observations on its behavior in this crop. As a result of these studies, in which he found that the larvae did not survive in flax, Farstad states:

> "As a potential pest of flax, *Cephus cinctus* Nort. appears to be of little importance. A relatively insignificant number of branches may be severed, and in combination with grasshopper feeding some breakage may occur. The value of flax as a crop for ridding a field of its sawfly infestation probably far outweighs the small economic loss that can be directly or indirectly attributed to this insect".

A possible addition to the complications involved in the control of the wheat stem sawfly presented itself during the summer of 1944. It has previously been considered that this insect had one generation annually. On July 18th, an untouched stubble field infested in 1943 (south of Ethridge in Toole County) was examined by P. D. McElliott and R. G. Newell. At this time, when the overwintering larvae should have pupated and emerged, approximately 50 percent of the infested stubs contained full grown, living and active larvae. Normal pupation and emergence had apparently taken place in the remainder of the infested stubble. On the basis of this observation, there may be a possibility that under certain conditions a population may go through two seasons before emerging as adults. There is insufficient information on this point at the present time to draw any conclusions, but the possibility cannot be overlooked.

[3]War circular 6, Mont. Agr. Exp. Sta. January, 1944.

[4]Wheat stem sawfly in flax. Scientific Agriculture, 24:8, pp. 383-386, April, 1944.

OTHER IMPORTANT INSECT PESTS, 1943-44

POTATO INSECTS

POTATO PSYLLID (*Paratrioza cockerelli* Sulc).—To summarize the infestations of this pest of potatoes and tomatoes for the seven years that observations have been made, the first recognized outbreak of these insects in Montana occurred in 1938, when it was estimated that the potato crop for the State was reduced by 25 percent, due to its activities. Populations fluctuated below the 1938 level with a trend downward until 1943, when no specimens were collected. The survey of that year (made from July 1 to 6 inclusive) embodied 3350 sweeps in potatoes on 28 properties in Stillwater, Carbon, Yellowstone, Big Horn, Rosebud, Custer, Prairie, Dawson, Richland, Valley, Phillips, Blaine, Hill, Chouteau, and Cascade counties. No psyllids were found, nor was there any report later of purple top in potatoes. In 1944 the survey was made from June 24 to 29, and much the same area was covered. Conclusions were drawn from 3200 sweeps in potato fields in Stillwater, Carbon, Yellowstone, Big Horn, Rosebud, Custer, Dawson, Richland, Phillips, Hill, Chouteau, and Cascade counties, and represented samplings from 23 premises. The survey indicated the presence and possible resulting damage in the Yellowstone Valley from Yellowstone to Custer counties. Only slight infestations were present at the time the survey was made in the eastern part of the Triangle area in north-central Montana.

Some symptoms of the psyllid-caused disease were noted near Hardin on June 24 in Bliss Triumph plantings, and others were reported to this office as the season progressed.

The long-time viewpoint on psyllid control involves discovery of methods of predicting outbreaks in sufficient time to plan and prepare for control measures. To the south of Montana psyllids are present in damaging numbers sufficiently often that there is justification in recommending the application of control measures every year. In Montana the experience of the last seven years indicates that the opposite is true. Infestations are so sporadic that it is not economical to recommend annual control, for the cost of this control over a period of years when it might be unnecessary could be greater than the occasional loss sustained. This makes it obvious that the immediate needs for information concerning the potato and tomato psyllid are for methods of prediction.

The annual survey for this insect serves two purposes. First, it records the fluctuations in psyllid populations. This information is then available for later study and correlation with factors which

may shed light on the causes of the fluctuations, and it will probably be necessary to discover these causes in order to make predictions. Second, it makes possible prompt warning of the location of threatening populations. An attempt is made to make the survey sufficiently early each year to enable farmers to use control measures where needed.

FLEA BEETLES (*Epitrix* spp.).—Interest has arisen in these pests due to the recent separation of a new species from this complex group by L. G. Gentner of the Oregon Agricultural Experiment Station. This species, *E. tuberis* Gentner, is a much more injurious form than others in the west because of the habit of the larvae of boring into potato tubers. A large series of these insects were submitted to Mr. Gentner, who stated that the great majority of them were the common *E. subcrinita* Lec., a species commonly found on potato, tomato, radish, turnip, and cabbage leaves in Montana. There were no specimens of the tuber flea beetle present in the collections, but unexpectedly one specimen of *E. cucumeris* Har. appeared in a collection from potatoes at Laurel, July 2, 1941. This is the first record of this species in Montana, although the species is common in other parts of the country.

WHEAT INSECTS

HESSIAN FLY. (*Phytophaga destructor* Say.).—The first record of this insect in Montana was reported in the Twentieth Report of the State Entomologist in 1924, when it appeared in Richland, Roosevelt, Wibaux, and Dawson counties along the eastern border of the State. During that season some fields suffered losses as high as 30 percent. It did not again appear until 1930 when specimens were sent in from Baker in Fallon County.

During the summer of 1944 the attention of this office was again called to the presence of the Hessian fly in the State. Investigation disclosed its presence in an area, roughly, from Valley to Custer county and east. Its appearance was spotty, and injury up to 20 percent was reported for some spots in certain fields. Over the area as a whole, however, the injury was not great, and had it not been for considerable hail damage and resultant close examination of fields by hail adjustors it is probable that the most of the infestations would have gone unnoticed.

Upon the first notice of this insect in the State twenty years ago this office was considerably concerned about the future spread and activities of this pest. Now, with this two-decade period for observation, it appears that the pest is likely to be only occasionally sufficiently abundant to cause noticeable damage. The reasons for its sporadic appearance are not entirely clear. During the past season there was early dry weather during the growing season,

which was more than compensated for after June. During that month there was an excess of precipitation when compared to the average; in fact, some weather stations recorded a new maximum precipitation for June. This would lead one to believe that there was possibly a similarity between conditions in eastern Montana in 1944 and the midwest areas where the Hessian fly is constantly a threat to wheat, and that the excess precipitation of the past year brought on the infestation. In referring back to the 1924 outbreak, however, this is not immediately apparent. For the State as a whole the year 1924 was dryer than usual. For weather stations in the infested area there was no striking deviation from the average during the growing-season months. There is a similarity, however, between the years just preceding 1924 and those just before 1944. The growing season precipitation (April to August inclusive) for 1919 was very low, a little over four inches. The 1920 season approached the average for these months, and more than average precipitation fell during the growing seasons of 1921, 1922, and 1923. The years just before this latest infestation were also years of greater than average precipitation during the growing season. Nineteen hundred and thirty-nine was less than average by about an inch. During 1940 the precipitation was average, and during 1941, 1942 and 1943 there was more than average rainfall. In examining only the one factor of precipitation, these data would indicate that the two obvious outbreaks of the Hessian fly have followed three seasons of more than average precipitation and have been sufficiently great to be noticed on the fourth. It would not be accurate to state that this is the only factor affecting the increase of this pest nor can we state that the Hessian fly outbreaks will always follow precipitation conditions outlined above. It is very probable that it is present in Montana every year but that it expresses itself in injurious populations only when conditions are proper for a build-up.

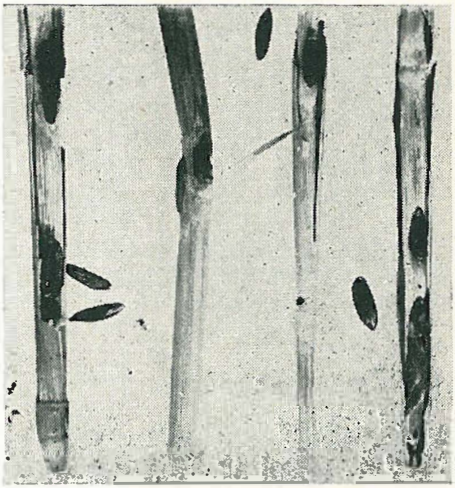

Figure 5. Hessian fly. Shows "flaxseed" pupae in typical location just above the nodes. Somewhat enlarged.

The Hessian fly is a small, weak midge, and is seldom noticed in the field. Its eggs are laid on the leaves of the wheat plant,

and the larvae move down into the leaf sheath upon hatching. In this position they feed on sap which exudes from injuries which they make in the plant tissue. At full growth they develop into the "flax seed" stage within the leaf sheath. There are probably two generations a year in Montana, and the winter is spent only in the "flax seed" stage. Wheat attacked in the fall does not grow well, and usually takes on a bluish-green tinge. The leaves become thickened and stand erect. When heavily infested the plants will die during the winter. Spring infested plants are usually characterized by weakened stems which break over as the head fills. The break is not clean and usually occurs above the leaves, thus differing decidedly from that of the wheat stem sawfly, where the stems break completely off usually near the ground line.

In controlling Hessian flies three methods of attack are successfully employed. First, late planting of winter wheat, after the fall generation of flies has appeared and disappeared, will eliminate fall attack. In states to the east where the flies are a constant threat this "fly-free" date has been worked out on a geographical basis, delaying the planting later and later as one progresses south. This fly-free period has not been ascertained for Montana, for in years past it has not been necessary to consider this insect as a pest. Second, all volunteer wheat in the fields, margins, around straw stacks, granaries, etc. should be destroyed to reduce the overwintering population. Third, where feasible, plowing under the stubble as soon after harvest as possible is desirable.

WHEAT JOINTWORM (*Harmolita tritici* Fitch).— An infestation of this insect in wheat, involving approximately 3000 acres was examined south of Columbus in Stillwater County during the summer of 1943. In places straws were up to 60 percent infested and the reduction in yield was substantial. The infestation in this area in 1944 had disappeared and there was no record of loss in this area. According to County Agent Payne, farmers in this area in the fall of 1943 did a considerable amount of fall plowing and stubble burning and this may have had its effect on the population.

MISCELLANEOUS RECORDS AND OBSERVATIONS

PEA WEEVIL (*Bruchus pisorum* (Linn.)).—A rather extensive survey in 1944 in the intermountain valleys where peas are grown for seed and dried peas showed the pea weevil to be present only in the vicinity of Missoula. Ravalli County was surveyed under unfavorable weather conditions but it is believed the survey was valid. Survey of Lake and Flathead counties was extensive and thorough but no weevils were found. An infestation of 2-5 percent was reported in some peas grown in Flathead County in

1943. This infestation was believed to have resulted from infested seed, which was not fumigated before planting. All seed planted in 1944 was weevil-free, and apparently the 1943 infestation died out. There are few suitable hibernation places in the Flathead Valley and this perhaps accounts for the elimination of the infestation.

Southwest of Missoula moderate to heavy infestations were encountered. Infestations of 2.3, 2, 14.5, and 5.8 weevils per 100 sweeps were recorded. Since all seed planted in this area was weevil-free, it is apparent that successful hibernation has occurred. Harvest data are not available for these fields but it is known that the third field was abandoned. In the infested area there are plenty of adequate hibernation places available. Continued increase in weevil populations may seriously affect the growing of seed peas in the Missoula area.

ALFALFA WEEVIL (*Hypera postica* Gyll.).—Records of the occurrence of this insect in the State have been briefly reviewed previously[5] and will not be repeated here. An additional record representing a slight extension of the range has been obtained since that time. On June 16, 1943, Mr. R. H. Newton of the United States Bureau of Entomology and Plant Quarantine obtained a few larvae in an alfalfa field located near where the Billings-Hardin highway crosses Pryor Creek in southern Yellowstone County. These larvae were retained alive in a vial by Mr. Newton, and the parasite *Bathyplectes curculionis* Thom., was reared from them. As there have been no liberations of these parasites in the State it is apparent that the weevils have brought the parasites in with them as they have progressed north from the Wyoming boundary.

The area infested with the alfalfa weevil in Montana is apparently small and restricted, and the infestations to date have been light. In this connection it is interesting to refer to a paper by Cook[6] published nearly 20 years ago, in which the probable distribution of the alfalfa weevil is outlined. Cook divided the western United States into three types of areas related to the probable success of this invading pest. The first is the area of normal occurrence where severe infestations may occur, and second is an area of occasional occurrence where periodic infestations depending on climatic fluctuations may occur, and the third is an area of possible occurrence where the weevil might become of minor economic importance after a series of favorable years. There are no areas noted in Montana where severe infestations may occur. The second degree of infestation, occasional occurrence, may appear west of the Divide and north about to Flathead and

[5]Mont. Agr. Exp. Sta. Bull. 384, p. 23, 1941.
[6]Jr. Agr. Res. 30, pp. 479-491, 1925.

Lincoln counties, and in a small area in Big Horn and Yellowstone counties. Areas of possible occurrence are scattered throughout the central part of the State. The interesting point is that the present Montana infestation falls within the small area of occasional occurrence in the south-central part of the State, where, according to Cook's calculations, it might be most expected to occur. The known infestation in the State is eight years old, and it has spread to the outer limits of this area of occasional occurrence.

Assuming the correctness of Cook's conclusions, the alfalfa weevil should never become a great pest in Montana, and measurable damage to alfalfa should occur only rarely and in limited areas in the State.

TIGER MOTH (*Callarctia blakei* Grote).—In 1944 larval specimens of this tiger moth were submitted for identification from Yellowstone and Choteau counties. In Choteau County it was reported damaging a wheat field during the latter part of April. An investigation revealed the larvae had invaded a field of winter wheat either from adjacent stubble, or rangeland at the end of the stubble, probably the latter. About five acres had been fed over by May 3, but the young leaves had not been entirely destroyed. Good growing weather enabled the field to recover and by harvest it was not possible to distinguish the infested area.

STRAWBERRY CROWN MINER (*Aristotelia fragariae* Busck).—This pest of strawberries previous to the autumn of 1944 had not been reported to this office or observed in the field in Montana. It has long been known in the Pacific Northwest, both in Canada and in the United States, and it is no great surprise to find it in this State. Almost simultaneously infested plants were sent in from Charlo and Findlay Point in Lake County, for identification and control measures.

The adult of the strawberry crown miner is a small moth with a wing spread of about a half inch. In itself it does not damage strawberry plants. The larvae, however, bore through the crowns of the plants causing poor development of the leaves and a general stunting of the plant. These larvae are typical moth larvae, pinkish in color, and about a half inch long. Their borings open up the crown and roots to the attacks of injurious fungi. Healthy, vigorous, young plants are seldom attacked. No artificial control measures have as yet been developed. Infested plantings should be plowed up and replanted, and where possible the old plants should be raked and destroyed.

EUROPEAN EARWIG (*Forficula auricularia* L.).—The spread of this introduced insect in the State has been reported in the last two reports of the State Entomologist. During the last biennium it has appeared in two new areas, Bozeman and Great Falls. In

neither place have the infestations reached any great proportion as yet.

SPRUCE TUSSOCK MOTH (*Olene* near *plagiata* Wlk.).—Since 1939 there have been reports of larvae of a large tussock moth partially defoliating spruce trees in the city of Billings. Investigations of the infestations, rearings, and determinations by Heinrich have established the identity of the species causing the damage. Defoliation has not been excessive in the trees examined, and at least one of the premises infested in 1943 was apparently free of the pest in 1944. Lead arsenate sprays have been recommended and have given control.

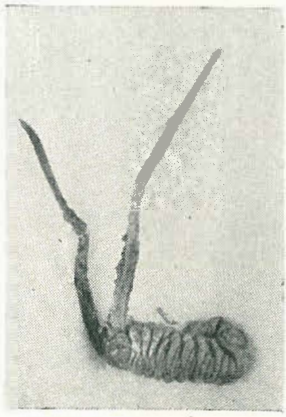

Figure 6. Diseased white grub. Tusk-like growths are fungus which killed grub. (Somewhat enlarged).

WHITE GRUB PARASITE (*Xylaria* sp.). The grubs of the June beetle *Phyllophaga anxia* Lec. were received from County Agent Stanley Halvorson in Hamilton, on April 24, 1944. They were attacked by a fungus, the fruiting bodies of which were emerging from the region of the head. These were identified by Dean F. B. Cotner as belonging to the genus *Xylaria*. Later specimens attacked by the same organism were received from others in Hamilton. Apparently the disease was common on white grubs in that locality, and is recorded because of the unusualness of such records in the State.

MAGGOTS ATTACKING A HUMAN (*Wohlfahrtia meigeni* Schin.).—In the Twenty-ninth Report of the State Entomologist[1] is recorded the attacks of maggots on young mink. The larvae were reared and proved to be those of a large fly, *Wohlfahrtia meigeni* Schin. On July 12, 1943, specimens of maggots were received from Dr. E. M. Joneschild of the Livestock Sanitary Board in Helena. Concerning these maggots Dr. Joneschild stated that they had been removed from a baby in Great Falls. A fly had been seen in the baby buggy under the mosquito netting and had apparently attacked the child as it cried out. Not long afterward eight or nine red spots appeared on the child which at first were considered to be mosquito bites. However, these areas enlarged, and about three days afterward a portion of the maggots were seen protruding from the openings, and a doctor was consulted who extracted them. But one live specimen reached this office on the 12th and it was immediately placed in a pupating jar, in which it emerged as an adult male fly of the above-named species on the 27th. The specimen was

[1]Mont. Agr. Exp. Sta. Bull. 408, p. 25, 1942.

pinned and returned to the Livestock Sanitary Board in Helena.

This is the first record of this species attacking humans in Montana of which we have knowledge, although there are several such records in the literature from other parts of the continent, and interesting discussions of Wohlfahrtia attacks by Dr. E. M. Walker[8]. These observations were made on the closely related eastern species *W. vigil* Wlk. which appears to differ but little from the western form *W. meigeni* Schin. in its biology. It is thought that the above case should be recorded as it is the first in the State.

OX WARBLES (*Hypoderma lineatum* De Vill. and *H. bovis* De G.).—During this war period there has been considerably more emphasis placed on the control of these pests than in the past. What appear to be practical control measures have been worked out for the first species in states to the south of Montana, but there is a dearth of adequate information on the biologies of the two species in this area as they may affect the controls applied.

A cooperative project between this department and the Veterinary Research Laboratories and the Department of Animal Industry is now gathering data on the practicability of controlling warbles under Montana conditions and a considerable amount of biological data are being collected. Wherever collections have been made at the proper time both species have been present, and it is probable that they both occur throughout the State. As soon as sufficient information is available to indicate the significance of these data they will be released by the cooperating departments.

BIENNIAL REPORT OF THE MONTANA STATE APIARIST, 1943-44

During the past biennium the Office of the State Apiarist has functioned in the various capacities provided by law. Its most important activity is that of maintaining control of bee diseases by apiary inspection. In addition the State Apiarist has acted as a source of information and advice on the technical problems of many individual beekeepers, assisted in keeping the bee industry in contact with the various government agencies and regulations, at times presented the cause of individuals and the industry to these agencies, studied the opportunities and the utilization of Montana's honey-producing resources, and also studied some of Montana's needs for the services of bees in the pollination of crops.

In the previous report[9] it has been shown that beekeepers in Montana fall into two groups, an amateur group of 600 to 700

[8]Jr. Parasitology, Vol. 7, pp. 1-7. 1920, and Vol. 9, pp. 1-5, 1922.

[9]Mont. Agr. Exp. Sta. Bull. No. 408, pp. 26-28.

persons who own small numbers of bee colonies and engage in very limited operations, and a professional group of about 75 individuals who own and operate commercial establishments. The latter group is here spoken of as the "bee industry".

Beekeeping has expanded in Montana from a total of 30,000 colonies operated in 1941 to 44,000 in 1944. However, the last two years have shown a distinct drop in production per colony with the result that Montana's crop the last two years has been lower than that of 1942. The present expansion is largely accounted for by movement of apiaries from other states, and in lesser part by the expansion of existing establishments within the State. There has not been a corresponding expansion in the number and size of amateur-operated apiaries. Hence, the bee industry operates an even larger proportion of the bees in the State than the 93 percent reported in 1942.

AMERICAN FOULBROOD CONTROL

Inspection of apiaries for control of American foulbrood has been limited by available funds and personnel. Hence, it has been necessary to set up limited objectives. Briefly, the objective has been to eliminate sources of disease which are not being adequately controlled. This has meant the inspection of amateur-operated bees and such limited supervision of the bee industry as seemed both necessary and possible. It has been impossible to embark on a program of uniform inspection and uniform control. As will be shown it appears that control, such as the burning of all diseased bees, would not be so effective in Montana as it has been in most parts of the country. Inspection results for 1943 and 1944 are presented in table 4.

It is clear from the data reported that progress has been made over the area where control has been attempted. Both the incidence and distribution of the disease is being cut down. It is also clear that the totals are small and easily influenced by any class represented.

Table 5 indicates that there exists a small group of operations which reflect unfavorably upon the total results. The 11 apiaries selected for removal from the 1943 total and 17 from that of 1944 were commercially operated apiaries which had not been previously inspected. They were in no case disease or hospital apiaries into which diseased colonies had been moved for operation or treatment. The above apiaries are certainly not representative of commercial operations in general. However, they do indicate that a serious disease problem still exists within the commercial bee industry. If progress is to continue, the commercial industry must be brought under closer surveillance than has been possible with the present program.

TABLE 4.—INCIDENCE AND DISTRIBUTION OF AMERICAN FOULBROOD IN APIARIES INSPECTED IN 1943 AND 1944

County	Colonies inspected	Colonies A. F. B.	Apiaries inspected	Apiaries infected
		1943		
Beaverhead	7	0	1	0
Big Horn	120	89	3	3
Blaine	32	0	4	0
Broadwater	1	0	1	0
Carbon	71	8	4	1
Cascade	112	30	22	9
Flathead	64	8	12	4
Gallatin	85	20	14	4
Jefferson	36	2	8	1
Lake	397	84	109	32
Madison	34	8	8	2
Missoula	124	71	28	15
Park	49	14	8	4
Phillips	2	0	1	0
Pondera	78	15	24	5
Ravalli	992	180	67	29
Stillwater	14	0	2	0
Sweet Grass	44	2	7	2
Teton	10	1	5	1
Yellowstone	267	27	31	9
Totals	**2,539**	**559** 22.0%	**359**	**121** 33.7%
		1944		
Blaine	30	6	3	2
Carbon	18	0	3	0
Cascade	33	3	7	2
Flathead	163	45	28	6
Fergus	101	3	18	2
Gallatin	73	1	6	1
Jefferson	28	0	6	0
Lake	656	66	85	21
Madison	214	114	8	5
Missoula	104	31	25	12
Lewis and Clark	46	8	7	3
Ravalli	461	60	34	8
Sanders	172	1	14	1
Musselshell	34	10	2	2
Wheatland	12	6	1	1
Yellowstone	392	54	36	12
Totals	**2,537**	**408** 16.1%	**283**	**78** 27.6%

During the spring of 1943 the State Apiarist recommended the use of American foulbrood-resistant bees as an approach to the problem. Through cooperation with the Iowa Beekeepers' Association, orders were pooled under a non-profit agency of the

State Apiarist and queens were made available to Montana beekeepers at volume prices. About 2000 queens were distributed to eighteen Montana beekeepers in this manner. The reaction from this experimental application ranged all the way from very satisfactory to very unsatisfactory. The queens were criticized more in regard to their quality as queens than as to their disease-resistance characteristics.

TABLE 5.—THE MOST DISEASED APIARIES INSPECTED IN 1943 AND 1944 AND THEIR INFLUENCE ON THE TOTAL RESULTS

No. apiaries inspected	No. colonies inspected	No. colonies A. F. B.	Percent infected	
	1943			
11 worst apiaries	389	219	56.3	22.0%
348 remaining apiaries	2150	340	15.8	
	1944			
17 worst apiaries	657	259	39.4	16.1%
266 remaining apiaries	1869	147	7.9	

The Montana foulbrood problem is more complicated than that of most states. Through so-called "wild bees" territory becomes easily contaminated with the result that belts of trees along rivers, rimrocks and old buildings become perennial sources of infection. There are some sites where 80 to 90 percent of the bee colonies go foul whenever apiaries are placed in them. In 1943 the State Apiarist inspected one ranch site where it was estimated that 14 to 16 colonies of bees had died of foulbrood in the walls of the buildings. A commercial apiary of 100 colonies within one and one-half miles of the ranch buildings became completely contaminated, and was the reason for investigation. Elimination of the source was impractical, the apiary was salvaged by the operator without penalty, and the apiary site was abandoned.

Such incidents as the above are numerous. They definitely demonstrate that there is a relationship between swarm control and disease control in Montana, and also that methods different from those generally used and recommended must be applied in these cases. Existing methods of control by eliminating sources of infection become impractical if not impossible.

It can still be stated that the main sources of infection occur within beehives operated by man. The bee-tree story is a fact in Montana but is also amplified to become the alibi for careless operation. The bee industry is expanded and many operations are undermanned. Operators have less time for swarm control and disease-control emergencies that arise. Within the limits of safe operation the present expanded production is admirable. How-

ever, there is no doubt that the present man-power shortage is aggravating the disease problem.

NOSEMA DISEASE

Infection with *Nosema apis,* a disease of adult bees, was coincident with the total decimation of one 20-colony apiary in Flathead County during the spring of 1944. This pathogen was also associated in 1943 with spring dwindling of colonies in one outfit brought from Idaho in May of that year. The Flathead infection was confined to one apiary. Other apiaries within the distance of one-quarter of a mile showed no serious affects. The only explanation as to source of infection appeared to be a half barrel in the apiary kept filled to constant level with an automatic water tap for watering purposes. The barrel remained open to contamination by the cleansing flights of the bees and the water was not changed during the spring period. Unfortunately the water in the barrel was not examined. The above isolated cases stand out because Nosema disease is not regarded as having serious consequences in Montana, though the actual role of the pathogen is not well understood. Most of the State Apiarist's efforts to find the infection in Montana apiaries have had negative results.

UTILIZATION OF HONEY PRODUCING RESOURCES

The Montana bee industry has had what might be called a small frontier until a very recent date. The unique position of the State Apiarist has made it both possible and desirable to study some of the areas where commercial honey production was undeveloped with the purpose of discovering new bee territories and bringing them into commercial production. As a result, in the last three years some 12,000 colonies of bees have been placed in sites believed to be productive. Information on new territory has been freely offered to individuals seeking it. Though final conclusions on the resources put to use and small areas still unused cannot be drawn, a report on this study is in order here.

Because of the short Montana season migratory beekeeping is considered impractical and little of it is practiced. Most colonies stand on the same spot year after year. Hence, the criteria of an apiary location should include both winter and spring requirements. Many of the criteria are not measurements but only rough estimates on the part of the operators after examining the area of proposed operations. However, some of the factors which limit honey production are measurable and are a matter of record. They are precipitation and other weather conditions, irrigation, legume hay, seed crops, soil, and physiography of the land. Certain factors are not of record, namely, amount of waste land, amount of volun-

teer sweet clover, secondary honey and pollen plants, and protection from prevailing winds. Further, beyond the generalities that sweet clover is our main honey plant, and that it requires moisture and favorable soil, no absolute evaluation of any of the supposed limiting factors in relation to the whole has been possible for any area during any particular year. The use of irrigation maps, weather records, Agricultural Census statistics of legume hay and seed crops, apiary registration records, and information on physiography has enabled the State Apiarist to select unused beekeeping territory with a high degree of success. Where combinations of favorable factors have been found, commercial operators have almost invariably confirmed the conclusions by examining the territory and putting it into production. There has been only one definite failure and this was attributed to a factor not found in any other area. Though it is too early to draw definite conclusions, the methods applied have resulted in the location of thousands of colonies of bees and the production of approximately 1,000,000 pounds of honey and 20,000 pounds of beeswax in 1944.

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